Recap Impulse and Momentum Collisions and Explosions Quiz Dec 12

eg. A 0.145kg baseball is moving at 90.0 miles/hour [90.0 mile/hr(1.609 km/miles)(1000m/km)(1hr/3600s)]
90x1.609x1000/3600=40.225 m/s
determine the momentum of the ball before and after and the impulse on the ball if

a) it goes through a window and slows to 32.0m/s?
p_i=mv = 0.145x40.225=5.8326 =5.83kgm/s
p_f=mv= 0.145x32=4.64 kgm/s
impulse=$\Delta p=p_f-p_i$= 4.64-5.8326=-1.1926 =-1.19 kgm/s

b) it hits a wall and stops. What is the impulse on the ball and wall?
p_i=mv = 0.145x40.225=5.8326 =5.83kgm/s
p_f=0
impulse = 0-5.8326=-5.8326 =-5.83kgm/s on the ball, on the wall = +5.83kgm/s

c) it is hit by a bat and goes back at -50.0 m/s. what is the impulse on the ball and bat?
p_i=mv = 0.145x40.225=5.8326 =5.83kgm/s
p_f= 0.145x(-50)=-7.25 kgm/s

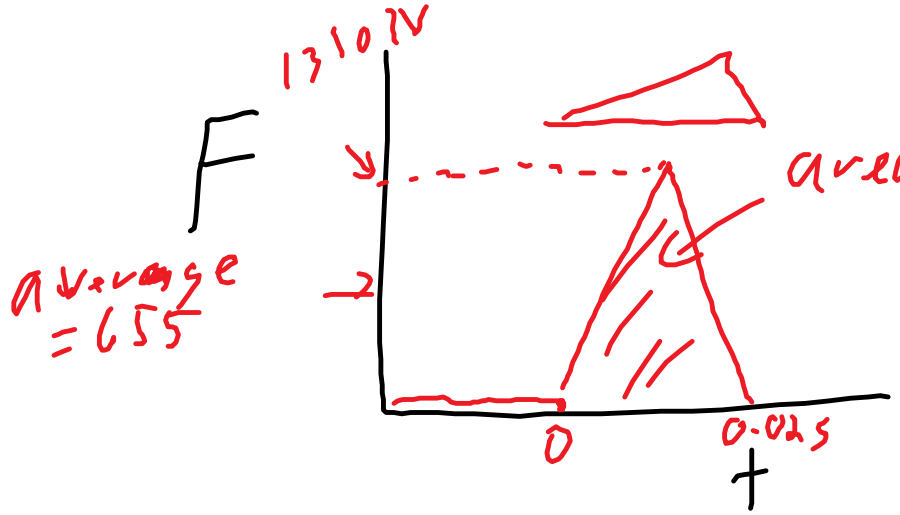
impulse = -7.25-5.8326=-13.0826 =-13.1kgm/s on the ball and +13.1kgm/s on the bat

d) in c, if the bat is in contact with the ball for 0.020s, what is

i)average force on the ball?

$\Delta p = F_{net}\Delta t$ or $F_{net} = \Delta p/\Delta t$ = -13.1/0.02=-655 N

ii) sketch F-t if F increases and decreases linearly



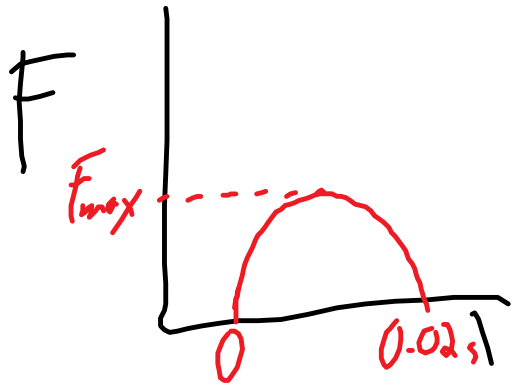
area $= \Delta p = F_{ave}\Delta t$

$\frac{1}{2} F_{max}\Delta t = \Delta p$

$F_{max} = \frac{2(13.1)}{0.02}$

$= 1310$ N

a) sketch F-t if F increases and decreases sinusoidally. (keeners)



$= \int_{t=0}^{t=0.02} F_{max} \sin\frac{\pi}{0.02} t$

$\Delta p = \frac{F_{max}}{\pi}\left[-\cos\frac{\pi}{0.02}t\right]_0^{0.02}$

$-\left(-\cos\frac{\pi}{0.02}0.02\right)$

$= 13.1 = \frac{2(1)F_{max}}{\pi}$

$F_{max} = 1029$ N

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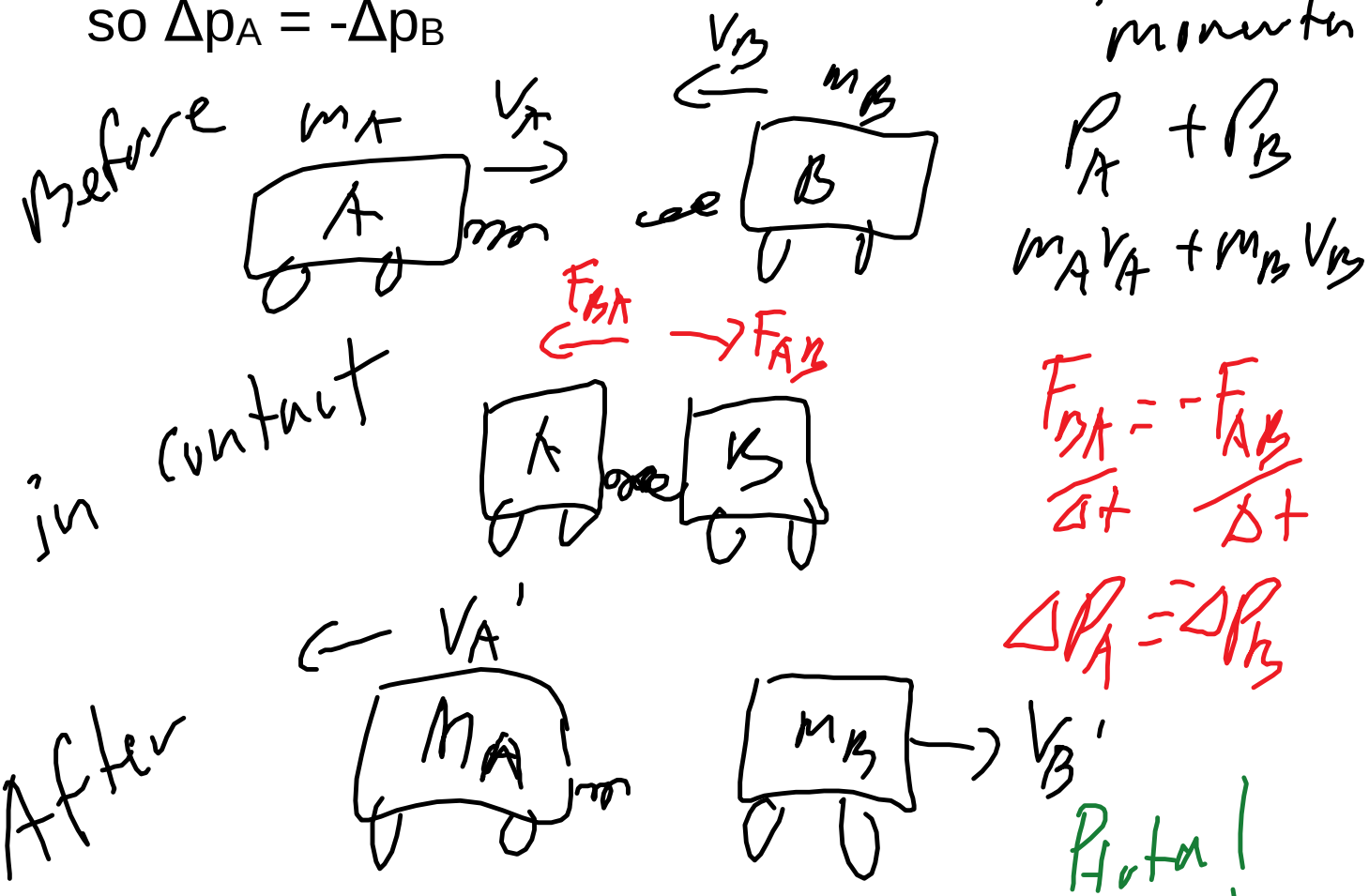
Collisions and explosions

- any problem that has a collision or explosion (things pushing apart) you think "momentum".
- Look at a system of two objects, A and B, that collide or push apart, the force A exerts on B = the force B exerts on A, and the time of contact is the same

  for A $F_{net}\Delta t = -F_{net}\Delta t$ for B

  so $\Delta p_A = -\Delta p_B$



total momentum

$p_A + p_B$

$m_A v_A + m_B v_B$

$F_{BA} = -F_{AB}$

$\frac{\Delta}{\Delta t} \quad \frac{\Delta}{\Delta t}$

$\Delta p_A = -\Delta p_B$

$p_{total} = p_A' + p_B'$

$= m_A v_A' + m_B v_B'$

$\Delta p_A = -\Delta p_B$

$p_A' - p_A = -(p_B' - p_B) = -p_B' + p_B$

$p_A' + p_B' = p_B + p_A$

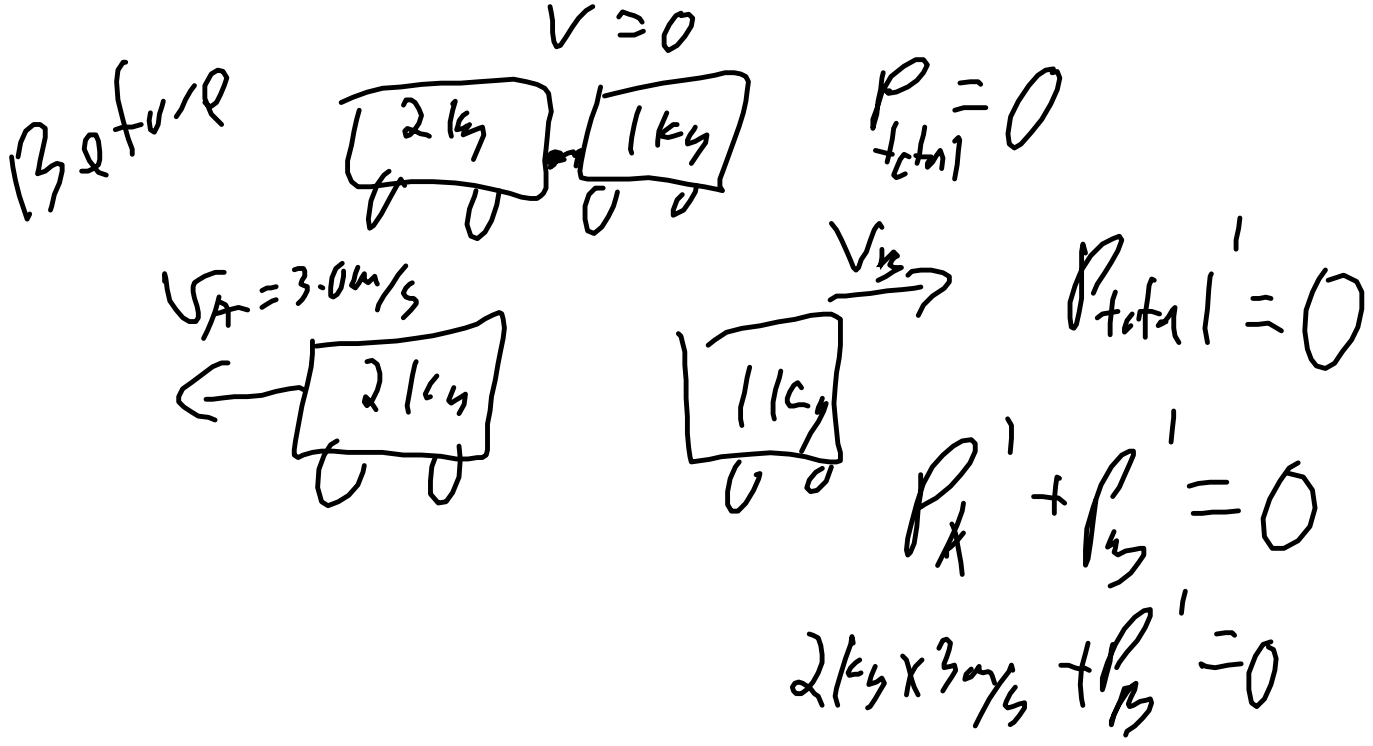
$p_{total}' = p_{total}$

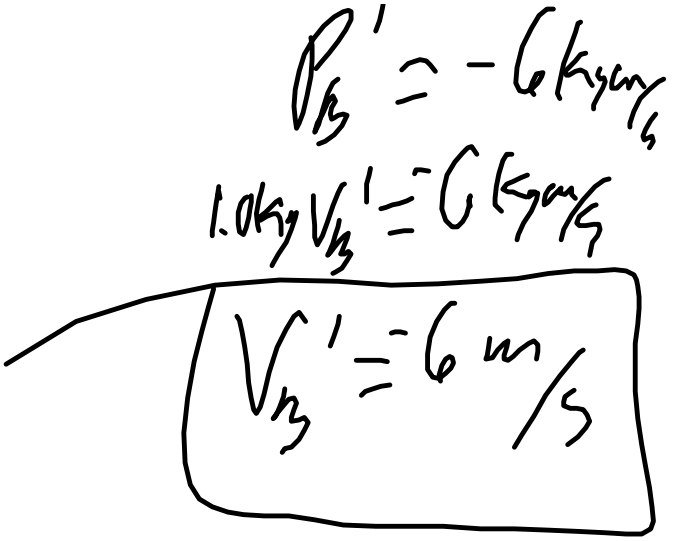
total final momentum = total initial momentum so momentum is conserved in collisions and explosions assuming no external forces (friction or slopes or air resistance) or objects - a closed, isolated system

eg.

1. You have a 2.0 kg cart and a 1.0 kg cart pushed together and they spring apart.

a) what is the velocity of the 1.0 kg cart if the 2.0 kg cart moves off with a 3.0 m/s velocity?





b) A spring with k = 200. N/m is compressed 10.0 cm between the carts. What is the energy stored in the spring? What is the velocity of the two carts after the explosion? (note the sum of the kinetic energy = elastic energy) (2kg and 1kg carts)

c) the 1.0 kg cart is moving at 4.0 m/s when it hits the 2.0 kg cart at rest. If the 1.0 kg cart bounces back at -1.0 m/s, what is the velocity of the 2.0kg cart? How much kinetic energy was lost in the collision? What forms did it take?

d) repeat c if the collision is perfectly elastic(no energy is lost , total kinetic energy is conserved) what are the velocities of the two carts after the collision?

e) repeat c if the collision is perfectly inelastic (they stick together and move off together).